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REMARKS

ON THE

OBSERVATIONS

OF

ROBERT WHITWORTH, Esq; Engineer,

UPON THE PLANS

DELIVERED TO THE RIGHT HONOURABLE THE

LORD PROVOST AND COUNCIL

OF EDINBURGH,

FOR ENLARGING AND IMPROVING LEITH HARBOUR.

BY C. CLARKE,

LECTURER ON NATURAL AND EXPERIMENTAL PHILOSOPHY.

EDINBURGH:

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TO THE RIGHT HONOURABLE

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CITY OF EDINBURGH.

My Lord and Gentlemen,

I Chearfully accord to your reſolution of appointing a perſon or perſons to review, and make report of the merit of the Plans offered to your conſideration, for the improvement of Leith Harbour.

Whether Mr Whitworth (being a candidate himſelf) is, or is not a proper perſon to decide on that important matter, I will not preſume to ſay; but certain I am he has deviated greatly from your intentions in the mode of conſtructing his obſervations or critic.

Inſtead

Inſtead of treating a reſpectable body of men, who, from the beſt and moſt diſintereſted motives of true patriotiſm, have contributed every thing in their power to aſſiſt your good intentions, and the public weal, with candour and judgment, he has attacked them with all the virulence and acrimony of an enraged viſionary.

Holding up to public view objections and difficulties, which never had, and never will have exiſtence, unleſs in his mind, againſt every part of every *Plan* except his own, although there are beauties and uſeful hints in every one of *them*, which I have ſeen, his I own muſt be again excepted.

His method of cenſure, I am ſorry to find, is of a malicious complexion: He praiſes, to diſguiſe his intention to criminate; he lampoons, ſcoffs, and leers, inſtead of open, candid argumentation; and never fails to adduce concluſions the moſt dogmatical and unfair I ever met with in any author or critic.

I dwell no longer, my Lord and Gentlemen, on Mr Whitworth's conduct as an author; for it cannot be doubted, even a recapitulation of ſuch matter, as he has exhibited in his pamphlet, will be full as grating and painful to you, as it is unpleaſant to myſelf.

Permit me now, my Lord and Gentlemen, to reaſon with him upon fair mechanical and mathematical principles reſpecting my Plan, which he has with every other perſon's Plan condemned *in toto.*

His firſt exception, and one he lays no little ſtreſs upon to depreciate my Plan, is the difficulty of making a wear or dam capable of fencing off the river.—As a full and fair *refutation* of his inſinuation on this head will bring before you, and a candid public, the purport

of

of Mr Whitworth ſounding ſuch a loud alarm, I ſhall bring *it* forward with all convenient brevity, and prepare, for that purpoſe, a demonſtration ſuited to every capacity, and ſuch as may be depended upon in that or any ſimilar caſe, the *rationale* of which will be given in a ſubſequent note.

The Wear I have propoſed, to turn the River into a new channel, is about 150 feet long, 20 feet high, and 60 feet thick, as appears by the Plan; and, to eſtimate the greateſt preſſure of water which can come againſt it, we proceed as follows, viz. Multiply the length of the *Wear*, 150, by *its* height 20, equal 3000; multiply the product by half *its* height, *i. e.* 3000 by 10, equal 30,000; and, as $62\frac{1}{2}$ pounds is the weight of one cubic foot of water, in order to find the preſſure in pounds, multiply the laſt product by 62.5, and the amount is 1,875,000 pounds, or greateſt preſſure of the water *. Thus we have found the impelling force; let us next find the reſiſting power; and, if the latter is inferior, or even only equal to the former, then Mr Whitworth's inſinuation is juſt, and his alarm well timed; if otherwiſe, it deſerves another name.

* As the particles of a fluid preſs in all directions equally, the preſſure of any particle againſt a perpendicular line, on a Wear or dam-head, is proportional to its diſtance from the top; therefore, the whole preſſure againſt ſuch line is as the ſum of the arithmetical progreſſion 0, 1, 2, 3, &c. continued from the top to the bottom of the fluid; the ſum of which arithmetical progreſſion is equal to the number of terms multiplied by half the greateſt; and, therefore, the preſſure on a line at the bottom of the fluid is double of that againſt an equal perpendicular one (or one extending from top to bottom). But, ſince the preſſure on the bottom line, and weight of the impinging fluid, are the ſame, in order to eſtimate the preſſure againſt any given area expoſed to the lateral preſſure of water, that *area* is to be multiplied by half *its* height in feet, and the product is the preſſure in cubic feet.

In order to make the compariſon altogether unexceptionable, I ſhall not take notice of any of the auxiliary circumſtances, although ſome of them, ſuch as the abutments, and conſtruction of the Wear being on the ſide oppoſite the River, an arch of 30 feet thick, with its convex ſide to the preſſure, and therefore capable of reſiſting above 300 times the weight of its materials, as the abutments are good. However, I ſhall wave theſe ſuperior things, and alſo the reſiſtance of the *water* in the harbour, (which, as *it* need not be leſs than 12 feet at any time when the River is in flood, leaves only 8 feet of Wear expoſed to the preſſure of the River) and ſhall oppoſe the bare weight of the materials of the Wear, placed on a proper foundation, which is eaſily found there, and properly connected, to the preſſure or force of the River, 20 feet deep, or one million eight hundred and ſeventy-five thouſand pounds.

Now, the Wear is 150 feet long, 20 feet deep, and 60 feet thick; 150 by 20, equal 3000; by 60, equal 180,000, the ſolid content; and, as ſtone and lime, or terras, in the proper proportion for building, are found to weigh 130 pounds *per* cubic foot, the laſt product ought to be multiplied by that number, and gives twenty-three million four hundred thouſand pounds to counteract the *force of the River*, and exceeds *it* more than twelve times; conſequently, Mr Whitworth's inſinuations are at any rate impertinent.

If Mr Whitworth was not able to find the reſult of this ſort of calculation, he is altogether unequal to the appointment you have honoured him with. If he was capable of performing the calculation, and either neglected it, or repreſented matters contrary to fact, he ſtands in a predicament truly deſpicable.

It is not on my own account I reſent this treatment in ſuch pointed

ed terms: It is on account of the embaraſſment he throws in your way, and for abuſing your confidence.

Another very ſerious alarm is proclaimed by your Engineer, againſt the diſcharge of the New Cut for the River. It is aſſerted, with the greateſt vehemence, that the River will point directly to the *Bar*, and overwhelm *it* with ſand, &c. And, to render his *ipſe dixit* more plauſible, he aſſerts, that I mean to make the *river* enter the ſands to the eaſt of the citadel; whereas, according to my plan, it is clearly evident *it* is deſigned to enter the ſands conſiderably to the weſt of the citadel, which greatly alters the circumſtance.

This proſtitution of truth, my Lord and Gentlemen, together with what has before appeared, and what will yet appear, convinces me that he is really below attention.

I ſhall, therefore, in what follows, direct my endeavours to explain the methods I had formed for extending the uſefulneſs of my plan, without regarding his inſinuations, or even mentioning his name, if I can avoid it.

To provide a proper channel for the river, after it enters the ſands or beech, weſt of the citadel, I always thought it neceſſary to make a ſlight tract or ditch, in a direction parallel to the Bar or tract the ſhips take the harbour in; and, as ſuch parallel cut, would be a quarter of a mile diſtant from the Bar, in the direction ſhips moſtly take the harbour, no part of the cut could injure the Bar or Channel, eſpecially as the ſands are continually found to ſhift in the direction of the current of the flood tide, or weſtward.

The mode of making ſuch cut is eaſy in the execution, and likewiſe in the expence, and provided for in my eſtimate, any inſtrument,

ment, a plough for inſtance, would make a rut or direction for a little *water*, and it would be prudent to ſend out only a ſmall *quantity*, untill the rut was well eſtabliſhed, and worked to a capacity to contain the river, which would ſoon happen, as the ſand is very favourable there to the deſign.

The neceſſary operation would be greatly facilitated by the labour of ſuch a number of men with ſhovels, as would keep the *ſand* in the bottom and ſides of the cut in motion before the water, as it deſcended on *it* during the time of ebb tide for a few days.

Thus, in a ſhort time, beginning a few days before a high tide, and continuing a few days after, (and ſuch tide my be known by my tide-table, notwithſtanding the vulgar and prejudiced may think otherwiſe,) a capacious chanhel may be made for the river.

And, to keep it continually open, and improving, no other precaution or further expence is required, than to ſupply it with water from the river in a convenient quantity, the reſidue may be ſent into the harbour or dock by the ſluices, provided for that and ſimilar purpoſes; but not noticed by your engineer, for reaſons beſt known to himſelf.

To confirm this aſſertion, we need no other teſtimony than analogy; let us therefore beſtow a little attention on the ruts, or guts as they are commonly called, obſervable on the ſurface of level beaches, ſuch as this, where water is diſcharged; the reſult continually is, an impreſſion on the beach in a direction congruous to the fall and conſiſtence of the ſoil and ſituation reciprocally. Hence it is, we ſee ſuch pleaſing ſerpentine waves on the face of ſhores, and have out-lets for water in marſhy countries bordering on ſhores and waſhes, as in the counties of Lincoln and Cambridge.

But,

But, as another, and irrefragable proof, of the practicability of grooving the river in the beach, in a direction no way hoſtile to the Bar or Harbour, occurs in this neighbourhood, I beg leave to refer to it alſo, viz. the cut made by the ingenious Mr Miln of Millfield, who ſends great quantities of fine building ſtone to *Dundee* and its neighbourhood, by ſhips of conſiderable burden; and, in order to ſtart the craft a convenient time before high water every tide, ſaw it neceſſary to make a groove of this ſort acroſs a wide beach into deeper water. This attempt, he owns was much cenſured by the wiſe-acres in general; but his ſucceſs ſince it was finiſhed, has ſilenced them all, and amply repaid him; nor is it any expence to keep it open; the ſmall rill of water ſent into it, preſerves its form and dimenſions, through the viciſſitude of *ſeaſons* in all *their* extremes. Upon this principle, my Lord and Gentlemen, I pointed out, in the narrative given in with my plan, a method of deepening the water on the Bar, and in the tract which leads to the harbour, (but as it has not been printed, your engineer has thought proper to ſtifle it,) and the diſcharges which may be made from the lock, whether the leſſer or larger deſign is adopted, is undoubtedly well calculated to anſwer that *deſirable end*.

If floods are (as has been aſſerted by your Engineer) the only means of doing *it*, ſix floods in a week may be made, and let off from the Baſon and River, all of them poſſeſſed of proper energy to affect the laudable deſign. The floods or guſhes of water from the baſon ought to be aſſiſted by a previous cut or groove, made by manual labour; a mode evidently preferable, in this ſituation, to the pricking of a hedgehog, or ſpikey roller, recommended by the Engineer. As to the *blockade* of mud and ſilt, which he has been diſpoſed to lay againſt the gates of the Dry Docks; if ſuch an impediment ſhould ever exiſt, a very ſmall inclination of the lower-gate of the lock would raiſe *it* with precipitation, when the diſcharges are

made; and the difficulty of ſtopping ſhips before they come bump againſt the Lock, merits no reply, as it is the eaſieſt of eaſy things, with ſkillful diligent ſeamen, to prevent it

When the Bar and Tract to the Harbour are thus improved, it is neceſſary to provide for the *ſtability* of ſuch improvements; in favour of which, I humbly preſume, great care ſhould be taken to prevent unneceſſary motion on the South Beach, I mean the ſhore from the Pier to the Glaſs-houſes, &c. as the ſand which lodges on the Bar, and in the Tract to the Harbour, is chiefly ſent from that quarter.

Permit me, therefore, to intimate, that ſcraping or hoeing the ſands, in any direction, between the Bar and that limit, to take fiſh, dig ſand, or gallop horſes, is highly injurious to the channel. This is not mere ſpeculation. I have frequently obſerved the *Bar augmented* when much exerciſe of that deſcription had been practiſed; and, what is ſtill more prepoſterous, ſcarce a day paſſes without cart-loads of rubbiſh being dropped on that part of the Beach, to the no ſmall increaſe of the *inconvenience* ſo ardently wiſhed to be prevented.

By attending duly to the above, and other particulars, (which, although neither numerous, nor expenſive in the execution, cannot be mentioned here with propriety), I will venture to ſtake the greateſt property I am poſſeſſed of, viz. my reputation and life, that, inſtead of *inevitably ruining Leith Harbour*, as improperly ſuggeſted by your Engineer, I would improve it very conſiderably in a few months.

And, with reſpect to the *general excellence* of the Harbour, according to my Plan, I think it no arrogance to aſſert that it has a ſuperior *ſhare* to any yet oppoſed to it. It affords accommodation for

fifty

fifty thouſand ton of ſhipping; the Trade is kept in its old channel; the Quay extended; the hours of loading or unloading made equal to the length of the day, at all ſeaſons; the craft leſs liable to be froze up than in any other ſituation; no land-floods to diſtreſs the ſhips, or their materials, or endanger the lives of their companies; and yet the River may be made of uſe to ſcour the Baſon itſelf, as well as the Channel and Bar, by uſing the ſluices in the Wear properly; a circumſtance of conſummate value, (but cannot be had in any of the other Plans), and all to be completed for leſs than twenty thouſand pounds.

In ſhort, were the whole wealth of the Indies at command, to procure a Harbour, you could not have a better of its ſize; or if the reſpectable Town of South Leith, and its environs, were ranſacked to the greateſt extreme, or even thrown into chaos, for the ſake of making a Baſon, or Dock, you could not be better ſerved, although the expence would undoubtedly be much greater, the accommodation leſs, and the completion more diſtant. And yet to me not a particle of merit is due; for the ſituation is pointed out by Nature. Never was there a ſtranger, poſſeſſed of diſcernment, that viſited Leith, who would not have made the ſame Report, if the queſtion had been put to him.

It is what every Briton, intereſted in maritime affairs, is looking up to you for, or ſomething equally good; and I have reaſon to expect, from your zeal for public good, and your diſcernment, that you will uſe every precaution againſt adapting a worſe. I am, with all due deference,

My Lord and Gentlemen,

Your obedient and faithful humble ſervant,

CUTHBERT CLARKE.

Leith, January 23. 1787.

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